SECTION 0302

CONCRETE STRUCTURES

0302.0100 GENERAL

0302.0101 Description of Work. The work under this Section shall consist of furnishing all materials and constructing concrete structures or parts of concrete structures to the forms, shapes, and dimensions shown on the project plans and to the lines and grades established by the Engineer and in accordance with the requirements of these specifications. When the structures or parts of structures are precast, the work shall also include transporting and placing the units.

0302.0200 PRODUCTS

0302.0201 Materials.

(A) Portland Cement Concrete. Portland cement concrete shall conform to the requirements of Section 0301 for Class A or Class B as shown on the project plans.

Where compressive strength is shown on the project plans without specifying a class of concrete, it shall be intended to mean Class A concrete with the minimum 28-day compressive strength shown.

(B) Concrete Curing Compound. Curing compound shall be a liquid membrane-forming compound conforming to the requirements in this Section.

(C) Expansion Joint Filler. Materials furnished for expansion joint filler and joint seal shall conform to the requirements of Section 1011 of the PAG Standard Specifications for Public Improvements.

(D) Reinforcing Steel. Reinforcing steel shall conform to the requirements of Section 0303.

0302.0300 EXECUTION

0302.0301 Foundations. Foundations for structures shall be placed on suitable earth or rock bearing, on a concrete foundation seal, or on piling, as shown on the project plans. Excavation and backfill shall be in accordance with the requirements of Sections 0203, 0204, and 0205. Except where tremie concrete is specified, no concrete shall be placed under water or against water-bearing strata.

0302.0302 Forms.

(A) Design and Drawings. The Contractor shall be responsible for designing and constructing safe and adequate forms that provide the necessary rigidity, support the loads imposed, and produce in the finished structure the lines, grades, and dimensions shown on the project plans and established by the Engineer.

Forms shall be any system of structural elements providing horizontal support or restraint to the lateral pressure of concrete.

(B) Construction.

(1) General. Forms shall be wood, metal, or other suitable material conforming to the requirements specified herein.

Forms shall be mortar tight and shall be designed, constructed, braced, and maintained so that the finished concrete will be true to line and elevation, and will conform to the required dimensions and contours. Forms shall also be designed to withstand the pressure of concrete, with consideration given to the rate of concrete placement, temperature of the concrete, use of set-retarding admixtures or pozzolanic materials in the concrete, effects of vibration as the concrete is being placed, and all loads incidental to the construction operations, without distortion or displacement. Forms shall be maintained to eliminate the formation of joints due to shrinkage of the lumber.

Stay-in-place forming shall not be used unless specified on the plans or approved by the Engineer. Expanded metal meshes may be used to form construction joints provided a 3-inch cover is maintained.

Forms shall be maintained at all times in good condition as to accuracy of shape, strength, rigidity, water tightness, and smoothness of surface. Forms or form lumber unsatisfactory in any respect shall not be used.

Forms shall be constructed so that portions may be removed without disturbing forms that are to remain. All form joints shall be taped or caulked in an acceptable manner.

Forms shall be filleted 3/4 inch at all exposed, sharp corners of the concrete.

All forms shall be treated with an approved form-release agent before concrete is placed. Any material that will adhere to or discolor the concrete shall not be used.

Forms shall be cleaned of all dirt, sawdust, water, and other foreign material prior to placing concrete in the forms.

Where the bottom of the form is inaccessible, provisions shall be made for cleaning out extraneous material immediately before placing the concrete.

(2) Wood Forms. All lumber used for forms shall be free of defects affecting the accuracy of shape, strength, rigidity, water tightness, and smoothness of the surface. All lumber for forms above a stream bed shall be plywood. All form lumber shall be securely fastened to the studding so that cupping cannot occur. Chamfer strips shall be

of selected material dressed to true line and uniform dimensions. Interior surfaces of all forms in contact with concrete surfaces that will be exposed in the finished work shall be smooth and even. No uneven or offset joints or single boards projecting so that their impressions are left in the concrete will be allowed. Forms, as far as practicable, shall be so constructed that the form marks will conform to the general lines of the structure. In general, lumber grain and direction of side joints shall be horizontal on wide faces and walls, and vertical on narrow faces. If varying panel widths are used, the wider panels shall be placed on the bottom and the narrower ones near the top. Panels and joints shall be staggered no less than 3 feet. Spreaders made of wood shall not be left in the concrete.

(3) Metal and Fiberglass Forms. Metal and fiberglass forms shall comply with the same provisions as those specified for wood forms in Subsection 0302.0302(B)(2). The following shall also apply:

All bolts and rivet heads shall be countersunk. Clamps, rods, pins, or other connecting devices shall be designed to hold the forms rigidly together and allow removal without damaging the concrete. Forms lacking a smooth surface or proper alignment shall not be used.

Care shall be exercised to keep the forms free of rust, grease, or other foreign matter that will tend to discolor the concrete.

(C) Removal of Forms. No forms shall be removed prior to the curing time specified in Section 0301.

In determining the time for removal of forms, consideration shall be given to the location and character of the structure, the weather, and other conditions influencing the setting of, and materials used in, the concrete.

The Engineer may reduce these times if high early-strength concrete is used or if the compressive strength of cylinders, cured under conditions similar to those in the field, indicates that the anticipated 85 percent of the 28-day compressive strength has been achieved. The Engineer may extend the above periods due to cold weather or other conditions that may retard the setting of the concrete.

Side forms for footings, curbs, or other members where the forms do not resist dead-load bending may be removed after the concrete has set; the Contractor shall cure and protect the concrete thus exposed in accordance with the requirements of this Section. The Contractor shall assume all risks and responsibility resulting from such removals.

Placement of backfill material shall be in accordance with Subsection 0205.0302. Where backfill is to be placed against both sides of a structural element, the backfill elevations on one side of

the element shall not exceed the backfill elevations on the opposite side of the element by more than 5 feet.

Care shall be taken in removing forms so as to not deface or injure the structure. Methods of removal likely to damage or cause overstressing of the concrete shall not be used.

0302.0303 Placing Concrete.

(A) General. No concrete shall be placed in a foundation until the extent of the excavation and the character of the bearing material have been approved, and no concrete shall be placed in any structure until the placement of reinforcing steel and the adequacy of the forms and falsework have been approved by the Engineer.

Formwork, reinforcing steel, waterstop, and **all materials required for the complete and satisfactory installation of concrete structures shall be complete, in place, 24 hours prior to any scheduled concrete pour** to permit adequate time for inspection work. Concrete shall not be placed until all necessary corrections have been made by the Contractor and all work required for the proposed pour has been completed.

Reinforcing steel shall be handled and placed in accordance with the requirements of Section 0303.

When concrete is placed on or against soil, the soil shall have been compacted—at its optimum moisture content—to no less than 95 percent of its maximum density. Prior to placement of concrete, the soil shall be mist sprayed with water so as to moisten all dry, absorbent surfaces with which the concrete will be in contact. Care shall be taken to avoid ponding water within the area of concrete placement.

Concrete shall be placed and consolidated by methods that will not cause harmful segregation or displacement of reinforcement, and will result in dense, homogeneous concrete free of honeycomb or voids.

Concrete shall be placed in horizontal layers not to exceed 18 inches in depth unless otherwise approved by the Engineer. When less than a complete layer is placed in one operation, the layer shall terminate in a vertical bulkhead. Each layer shall be placed and consolidated before the preceding layer has taken its initial set to prevent damage to the green concrete and avoid cold joints.

Concrete shall be placed as nearly as possible in its final position, and the use of vibrators for shifting the mass of fresh concrete will not be permitted. Dropping the concrete more than 5 feet without using approved pipes or tubes will not be allowed.

Care shall be taken to fill all areas within the forms, to work the coarser aggregates back from the face of the concrete, and to force the concrete under and around the reinforcement without displacing the reinforcement or other embedded items.

Conveying equipment shall be capable of providing a supply of concrete to the point of placement without segregation of ingredients or interruptions sufficient to permit loss of plasticity between placement of successive layers.

Concrete placed in slabs and floors shall be struck off by means of a screed. The screed may be self-propelled or manually operated.

When manual methods are permitted, concrete shall be deposited, spread, and struck off to such an elevation that—when properly consolidated—the surface will conform to the required lines and grades. The strike board shall be moved forward with combined longitudinal and transverse motions so that neither end is raised from the side forms. While striking off, a slight excess of concrete shall be kept in front of the cutting edge at all times.

No concrete that has partially hardened or been contaminated by foreign materials shall be deposited in the structure.

The rate of concrete placement and consolidation shall be such that the formation of cold joints within monolithic sections of any structure will not occur. Any portion of any structure displaying apparent cold joints will be rejected, unless the Contractor—at his/her expense—can submit evidence indicating that a cold joint either does not exist or is not detrimental to the structure. The Engineer shall be the sole judge in determining the existence of a cold joint and whether that existence is detrimental to the structure. The rate of concrete placement for major structures shall not be less than 35 cubic yards per hour unless otherwise approved in writing by the Engineer.

After the concrete has taken its initial set, care shall be exercised to avoid jarring the forms or placing any strain on the ends of projecting reinforcement.

(B) Pumping Concrete. Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall be of suitable type and shall have adequate capacity for the work. The concrete shall not flow either over or through any piping, fittings, or equipment fabricated of aluminum or aluminum alloys. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. Excessive segregation due to high-velocity discharge of the concrete will not be permitted. When pumping is completed, the concrete remaining in the pipeline—if it is to be used—shall be ejected in such a manner that there will be no contamination of the concrete or segregation of the ingredients. **Standby equipment shall be readily available to replace initial pumping equipment should breakdown occur.**

(C) Vibrating Concrete. All concrete in structures shall be consolidated by means of approved vibrators together with any other equipment necessary to perform the work as specified herein. The minimum frequency of the internal vibrators shall be as specified in

Table 0302-1 and produce a vibration of sufficient intensity to consolidate the concrete into place without separating the ingredients.

Table 0302-1
Vibrator Element Frequencies

Vibrator	Minimum Frequency (Cycles / Minute)
Surface, Pan or Screed	3500
Immersion Tube, Paving Machine Attachment	5000
Immersion Spud, Hand Operated	8000
Immersion Spud, Gang Mounted	8000

Vibration shall be applied in the area of the freshly deposited concrete. Vibrators shall penetrate to the bottom of the concrete layer and at least 6 inches into the preceding layer. The vibration shall be of sufficient duration and intensity to consolidate the concrete thoroughly within 15 minutes after being deposited in the forms. The vibrating element shall be inserted into the concrete mass in as nearly a vertical position as practicable, and withdrawn completely from the concrete before being advanced to the next point of application. Internal vibrators shall not be applied directly to the forms or to the reinforcing steel.

Vibration shall not be continued at any one point to the extent that localized areas of grout are formed. Application of vibrators shall be at uniformly spaced points not farther apart than twice the radius over which the vibration is visibly effective.

The vibrator shall not be used to push or distribute the concrete laterally.

To secure even and dense surfaces, free from aggregate pockets or honeycomb, vibration shall be supplemented by working or spading by hand in the corners and angles of forms and along form surfaces while the concrete is plastic.

Re-vibration of concrete may be required at any time as directed by the Engineer.

The Contractor shall provide sufficient equipment to ensure uninterrupted and continuous vibration of the concrete.

(D) Placing Concrete in Water (Tremie Concrete). Tremie concrete shall be deposited in water only if either specified on the project plans or when directed, and then only under the Engineer's supervision. When depositing in water is allowed, the concrete shall be carefully placed in a compact mass in the space in which it is to remain by means of a tremie, bottom dump bucket, or other approved method that does not permit the concrete to fall through the water without adequate protection. The concrete shall not be disturbed after being deposited.

No concrete shall be placed in running water, and forms that are not reasonably watertight shall not be used for holding concrete deposited under water.

A head of concrete shall remain above the discharge end of the tremie tube at all times.

0302.0304 Finishing Concrete.

(A) General. The appropriate finish, as specified herein, shall be applied to each surface of all concrete structures.

All formed surfaces will require finishing. Formed surfaces shall be finished immediately after the removal of forms in accordance with the requirements specified herein. If rock pockets or honeycomb are of such an extent and character as to affect the strength of the structure and endanger the steel reinforcement, the Engineer may declare the concrete defective and require the removal and replacement of that portion of the affected structure at the Contractor's expense.

Formed surfaces normally in view of vehicular or pedestrian traffic, or not covered by fill material, shall present a pleasing appearance of uniform color and texture commonly achieved by using clean, smooth plywood forms joined tightly or taped at the joints; preformed metal forms; paper tubing forms; or specially coated forms. If a pleasing appearance has not been achieved, either in the formed surface or at the joints, the Engineer will order the surface finished in accordance with the requirements for a Class II finish.

(B) Class I Finish. All bolts, wires, snap-ties, and rods shall be clipped and recessed 1 inch below the concrete's surface. All holes, honeycomb, rock pockets, and other surface imperfections shall be cleaned to sound concrete, thoroughly moistened, and carefully patched with mortar.

Mortar shall be composed of 1 part cement, 2 parts fine sand, water, and an adhesive of a type approved by the Engineer. A portion of the required cement shall be white as required to match the color of the surrounding concrete. Small voids due to entrapped air and water in precast members need not be patched.

(C) Class II Finish. The surface shall be patched and pointed as specified herein for Class I finish. When the mortar used in patching and pointing has set sufficiently, the surface shall be rubbed with cork, wood, or rubber floats; polystyrene; or a mechanical carborundum stone. During the rubbing process, a thin mortar matching the color of surrounding concrete may be used to help produce a satisfactory lather. The mortar used to produce a lather shall not be used in quantities sufficient to leave a plaster coating on the finished surface. Rubbing shall continue until irregularities are removed and there is no excess material. At the time a light dust appears, the surface shall be brushed or sacked. Brushing or sacking shall be carried in one direction so as to produce a uniform texture and color.

0302.0305 Curing Concrete. The Contractor shall be solely responsible for ensuring quality concrete operations at all times in order to prevent the formation of cracks. The appearance of cracks—other than normal, infrequent, sporadic, hairline, dry-shrinkage cracks—will be cause for rejection of the concrete.

Curing both cast-in-place and precast concrete members shall be in accordance with the requirements of Subsections 0301.0303(D) and 0301.0303(E).

0302.0306 Backfilling. Structure backfill shall be placed in accordance with the requirements of Subsection 0205.0302(B)(2).

0302.0307 Compressive Strength and Acceptance. Sampling and testing for compressive strength and acceptance for compressive strength will be in accordance with the requirements found in Subsection 0301.0303(E).

0302.0308 Repair of Defective Concrete. All defective work shall be removed and replaced or repaired. Any work not constructed in accordance with the plans and specifications shall be considered defective.

Correction of defective work shall be specified herein. No defective work shall be patched, repaired, or covered without Engineer inspection. Repair shall be equal to or greater in strength than the specified concrete for the area. The Contractor shall submit to the Engineer for review and acceptance a mix design for the grout proposed for use.

All imperfections in the work shall be chipped out and keyed ready for repair. The dry-pack method shall be used for holes with a depth nearly equal to or greater than the least surface dimension of the hole, for cone-bolt, and for narrow slots cut for repair. Smooth holes shall be roughened with a rotohammer before repair. The mortar method of replacement shall be used for holes too wide to dry pack and too shallow for concrete replacement, and shall also be used for comparatively shallow depressions, large or small, which extend no deeper than the reinforcement nearest the surface. Concrete replacement shall be used when holes extend entirely through the concrete section or when holes are more than 1 square foot in area and extend halfway through the section. All surfaces of the set concrete to be repaired shall first be coated with an epoxy bonding agent: Concresive 1001 LPL by Adhesive Engineering, Sikadur Hi-Mod by Sika Chemical Corporation, or approved equal. No repair shall be made until the Engineer has accepted the method of preparing the surface and proposed method of repair.

The color of the repair concrete dry pack and grout shall match that of the adjoining concrete. The use of white cement may be required to match color. The Contractor shall prepare test panels for proposed repairs at the beginning of the project for the Engineer’s review and approval. This panel will serve as a standard for repairs during the project.

Curing of all repaired concrete shall be the same as specified for concrete.